## CLAIMS

What is claimed is:

**1.** A fuel cell integrated on or into a unitary planar substrate having first and second sides comprising:

at least two stacked layers comprising a cathode layer and an ion exchange layer situated on or within the substrate, the ion exchange layer being oriented substantially within the plane of the substrate;

a first access path for allowing an oxidant to access the cathode layer from the first side of the substrate;

a second access path for allowing a fuel or a reaction medium containing a fuel to access a layer in the stack from the second side of the substrate;

a first conductor connecting to the cathode; and

a second conductor connecting to the second access path or the layer in the stack accessible through the second access path.

**2.** The fuel cell of claim 1 wherein the substrate comprises a semiconductor substrate.

**3.** The fuel cell of claim 1 wherein the substrate comprises an injection molded substrate.

**4.** The fuel cell of claim 1 wherein the fuel cell comprises a metal fuel cell.

**5.** The system of claim 1 wherein the fuel cell comprises a hydrogen fuel cell.

**6.** The fuel cell of claim 5 wherein the layer in the stack accessible through the second access path comprises an anode layer.

**7.** The system of claim 4 wherein the layer in the stack accessible through the second access path comprises an ion exchange layer.

**8.** The system of claim 2 wherein the substrate comprises an integrated circuit substrate.

**9.** An electrochemical power system employing one or more fuel cells integrated on or into a substrate having first and second sides comprising:

one or more fuel cells integrated on or into the substrate, each such fuel cell comprising:

at least two stacked layers comprising a cathode layer and an ion exchange layer situated on or within the substrate;

a first access path for allowing an oxidant to access the cathode layer from the first side of the substrate;

a second access path for allowing a fuel or a reaction medium containing a fuel to access a layer in the stack from the second side of the substrate;

a third access path, which may be the same or different from the second access path, for allowing egress of one or more reaction products from the layer;

a first conductor connecting to the cathode; and

a second conductor connecting to the second access path or the layer in the stack accessible through the second access path;

a regeneration unit integrated on or into the substrate comprising:

a reaction chamber integrated on or into the substrate which is capable of holding one or more reaction products, the chamber having an interior and one or more regions of ingress and one or more regions of egress;

an anode connecting to the interior of the reaction chamber; and

a cathode connecting to the interior of the reaction chamber;

a first flow path interconnecting the one or more third access paths of the one or more fuel cells with the one or more regions of ingress of the reaction chamber; and

a second flow path interconnecting the one or more regions of egress of the reaction chamber with the one or more second access paths of the one or more fuel cells.

**10.** The system of claim 9 comprising two or more integrated fuel cells coupled in series.

**11.** The system of claim 9 comprising two or more integrated fuel cells coupled in parallel.

**12.** The system of claim 9 wherein the substrate comprises a semiconductor substrate.

**13.** The system of claim 9 wherein the substrate comprises an injection molded substrate.

**14.** The system of claim 9 further comprising one or more reservoirs for storing one or more reaction products and situated along the first flow path between the one or more third access paths of the one or more fuel cells and the one or more regions of ingress of the reaction chamber.

**15.** The system of claim 9 further comprising one or more reservoirs for storing regenerated fuel and situated along the second flow path between the one or more regions of egress of the reaction chamber and the one or more second access paths of the one or more fuel cells.

**16.** The system of claim 9 further comprising one or more circulating means situated along the first flow path for impelling the one or more reaction products to flow along the first flow path.

**17.** The system of claim 9 further comprising one more circulating means situated along the second flow path for impelling the regenerated fuel to flow along the second flow path.

**18.** The system of claim 9 wherein the reaction chamber has one or more regions of egress for a second reactant.

**19.** The system of claim 9 wherein the one or more fuel cells comprise hydrogen fuel cells.

**20.** The system of claim 9 wherein the one or more fuel cells comprise metal fuel cells.

**21.** The system of claim 19 wherein the layer in each fuel cell accessible by the second access path comprises an anode layer.

**22.** The system of claim 20 wherein the layer in each fuel cell accessible by the second access path comprises the ion exchange layer.

**23.** A metal fuel cell integrated on or into a substrate having first and second sides comprising:

at least two stacked layers comprising a cathode layer and an ion exchange layer situated on or within the substrate;

a first access path for allowing an oxidant to access the cathode layer from one side of the substrate;

a second access path for allowing a reaction medium containing a metal fuel to access the ion exchange layer in the stack from the other side of the substrate;

a first conductor connecting to the cathode; and

a second conductor connecting to the second access path.

**24.** The metal fuel cell of claim 23 wherein the fuel comprises zinc.

**25.** The metal fuel cell of claim 23 wherein the reaction medium comprises potassium hydroxide solution.

**26.** The metal fuel cell of claim 24 wherein the zinc fuel comprises zinc particles.

**27.** The metal fuel cell of claim 23 wherein the second access path has an interior that is substantially chemically inert with respect to the reaction medium at the areas of contact therewith.

**28.** The metal fuel cell of claim 27 wherein the interior of the second access path is substantially chemically inert with respect to the reaction medium at the areas of contact therewith through suitable coating.

**29.** The metal fuel cell of claim 27 wherein the interior of the second access path is substantially chemically inert with respect to the reaction medium at the areas of contact therewith through suitable doping.

**30.** The metal fuel cell of claim 23 wherein the substrate comprises a semiconductor substrate.

**31.** The metal fuel cell of claim 23 wherein the substrate comprises an injection molded substrate.

**32.** The metal fuel cell of claim 23 wherein the second access path comprises a cavity in the substrate.

**33.** A method of integrating a fuel cell on or into a substrate comprising:

placing at least two stacked layers comprising a cathode layer and an ion exchange layer on a surface of a substrate;

forming an access path to one of the layers which extends inward from an opposing surface of the substrate;

connecting a first conductor to the cathode layer; and

connecting a second conductor to the access path or the layer which is made accessible by the access path.

**34.** The method of claim 33 wherein the forming step comprises an etching step.

**35.** The method of claim 34 wherein the etching step comprises a patterned etching step.

**36.** The method of claim 33 wherein the substrate is a planar substrate having first and second sides, and the surface is on the first side of the substrate, and the opposing surface is on the second side of the substrate.

**37.** The method of claim 33 wherein the fuel cell comprises a metal fuel cell.

**38.** The method of claim 37 wherein the layer accessible by the access path comprises the ion exchange layer.

**39.** The method of claim 33 wherein the fuel cell comprises a hydrogen fuel cell.

**40.** The method of claim 39 wherein the layer accessible by the access path is an anode layer.

**41.** The method of claim 33 wherein the surface of the substrate on which the stacked layers are placed is within a cavity.

**42.** A method of integrating a regeneration unit on or into a substrate comprising:

forming a cavity which extends inward from a surface of the substrate, the cavity having an interior and one or more regions of ingress and egress thereto;

connecting a first electrode to the interior of the cavity; and

connecting a second electrode to the interior of the cavity.

**43.** The method of claim 43 wherein the forming step comprises an etching step.

**44.** The method of claim 43 wherein the etching step comprises a patterned etching step.

**45.** The method of claim 42 further comprising capping the cavity with a cap.

**46.** The method of claim 45 wherein the second electrode is integrated on or into the cap.

**47.** A method of integrating a fuel cell on or into a substrate comprising:

forming an electrode assembly comprising one or more electrode elements, wherein each of the electrode elements in the assembly comprises at least two stacked layers comprising a cathode layer and an ion exchange layer; and

forming a substrate around the electrode assembly, with first and second conductors connecting a surface of the substrate to the electrode assembly, a first access path for an oxidant to the cathode layer in each of the electrode assemblies, and a second opposing access path for fuel or a reaction medium containing a fuel to one of the layers in the stack.

**48.** The method of claim 47 wherein the substrate forming step comprises an injection molding step.

**49.** The method of claim 47 wherein one of the layers in an electrode element is a conductor extending from another electrode element in the assembly.

**50.** The method of claim 47 wherein the one or more fuel cells comprise metal fuel cells.

**51.** The method of claim 50 wherein the layer in an electrode element accessible through the second access path comprises the ion exchange layer.

**52.** The method of claim 50 wherein the one or more fuel cells comprise hydrogen fuel cells.

**53.** The method of claim 52 wherein the layer in an electrode element accessible through the second access path comprises an anode layer.

**54.** The method of claim 53 wherein the anode layer in an electrode element is coupled to a conductor extending from another electrode element.

**55.** The system of claim 9 wherein the first flow path is integrated on or into the substrate.

**56.** The system of claim 9 wherein the second flow path is integrated on or into the substrate.

**57.** The metal fuel cell of claim 23 wherein the substrate comprises a unitary planar substrate.

**58.** A method of integrating a fuel cell on or into a substrate comprising:

a step for placing at least two stacked layers comprising a cathode layer and an ion exchange layer on a surface of a substrate;

a step for forming an access path to one of the layers which extends inward from an opposing surface of the substrate;

a step for connecting a first conductor to the cathode layer; and

a step for connecting a second conductor to the access path or the layer which is made accessible by the access path.